Sugarbeets Grown on Fumigated Soils

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Summary

A field study was initiated at three locations in northwest North Dakota and northeast Montana to study yield and quality losses of sugarbeets grown in various rotations . Methyl bromide, a soil fumigant, was used to reduce disease, nematode and insect populations in replicated plots. After fumigation, producers seeded the plots along with the rest of the field. In a sugarbeet-wheat rotation, Fusarium was identified as a cause for reducing seedling and harvest stands. Fewer seedlings per acre were found growing on fumigated treated plots at the two other locations though there was no difference in harvest stands between fumigated and non-fumigated plots at one location. Sugarbeets grown in methyl bromide treated soil had significantly higher potassium content, higher impurity index, greater loss to molasses, and lower percent extraction than sugarbeets grown on natural soil plots.

Introduction

Sugarbeets are grown on approximately 14,000 acres in western North Dakota (North Dakota Agricultural Statistics, 1998). Producers know that sugarbeet is a high value crop and want to include it in their crop rotation plans as often as they can. However, disease and nematode problems may reduce yield and quality of the crop substantially making the crop less profitable. Rotation with non-host crops is known to provide time for the reduction of pathogen and nematode populations but may require eight to ten years between sugarbeet crops to reduce sugarbeet cyst nematode and three years or longer to reduce sugarbeet root pathogens.

Materials and Methods

Three sites were selected with different rotational histories in northwest North Dakota and northeast Montana (Table 1). The Flynn and Karst sites were located east of Fairview, ND and the other site was located on the Eastern Agricultural Research Center (EARC) near Sidney Montana. A randomized complete block design with six replications was used at all locations. Each plot was 180 ft2 (16.7 m2) Fields at the Flynn and Karst sites were bedded prior to fumigation while the EARC site was level. Plots to be fumigated were covered with a six mil plastic sheet, edges buried in trenches four to six inches deep to seal the covered area, and methyl bromide was metered through plastic hoses at the rate of one pound per 100 ft2 (50g m-2). The fumigated plots remained covered for 48 hours after which time the plastic was removed. Non-fumigated or natural soil plots served as checks. After the plastic was removed, producers farmed through the fumigated and natural soil plots with their normal management practices.

Stand counts were done at emergence and again at harvest. Soil and sugarbeet tissue samples were analyzed by Dr. Barry Jacobsen, extension plant pathologist, Montana State University, Bozeman, MT for disease and nematodes during the season. The center row of the three-row plot was harvested, and measured for yield and quality. American Crystal Sugar Company, Sidney, Mt performed the quality analysis.

Results and Discussion

Plant Stand

Plant stands appeared to be injured by the methyl bromide treatment at the EARC (Table 2) and Karst (Table 3) sites. Soils at both of these sites contain more clay than at the Flynn site with the EARC site containing the highest clay content of any of the other sites in the study. Seeding of the Flynn site occurred within 24 hours of tarp removal while at the Karst site and at the EARC site, a two-day and four day, respectively, period of time had elapsed before seeding. Though seedling stand counts were less on the fumigated plots than natural soil plots at the Karst site, there was no significant difference at harvest.

At the Flynn site plant stands at the seedling stage and again at harvest were less in natural soil plots compared to the fumigated plots (Figure 1) (Table 4). Fusarium (Figure 2) was identified at the Flynn site and this pathogen greatly reduced the stand in the natural soil plot. The Fusarium infection was variable within this test site, and reduced stands in some plots of both natural and treated soils, although they were reduced more in natural soil plots.

When analyzed across sites, fumigated soil resulted in lower seedling stand, although by harvest, stands in natural soil plots were slightly lower than those in fumigated soils (Table 5). Significant location X treatment interactions were detected for both seedling stand and harvest stand.

Van Berkum and Hoestra (1979) suggested that waiting for a period of time between application and seeding is usually not more than seven to ten days when methyl bromide is used to fumigate soils. However in cold and wet soils such as in early spring fumigation, the amount of time between fumigation and seeding should be extended.

Fumigation with methyl bromide is known to be selective and control some fungi such as a number of Fusarium spp. to be incomplete as is found in partially fumigated soils such as used in this demonstration. (Vanachter V., 1979). Chloropicrin is known to be more effective in the control of Fusarium spp. than methyl bromide (Wilhelm and Koch, 1956)

Yield and Quality

No differences were detected between fumigated and natural soil plots at the Karst (Table 3) site. At the EARC (Table 2) site sugarbeets harvested from the methyl bromide treated plots had a lower sucrose content and greater impurities than sugarbeets grown on the natural soil plots. This response may be due in part to the reduced stand. At the Flynn (Table 4) site, root and sucrose yields tended to be greater in sugarbeets grown on fumigated plots compared to natural soil plots but this increase was not significant because of the variability caused by Fusarium within this test site.

Sugarbeets grown in natural soil had significantly lower potassium content, lower impurity index, less loss to molasses, and greater percent extraction than sugarbeets grown on methyl bromide-treated soil.

Implication of Demonstration

Where Fusarium was identified as a cause in reducing stand counts in sugarbeet, yield and sucrose yield reductions occurred. Fusarium was also noted in the fumigated plots but to a lesser degree. Chloropicrin may be needed to reduce Fusarium spp. populations but in doing so may require changes in conducting this demonstration.

Additional data should be collected over the next several years to identify yield and quality reducing factors and to establish the role that crop rotations and other management practices may have on sugarbeet production.

Cooperating Producers

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Table 1. Cropping history and agronomic practices at selected fields in northwest North Dakota and northeast Montana, 1999.

Site	Rotation	Sugarbeet variety	Planting Date	Harvest Date
Eastern Agricultural Research Center	1996 - Sugarbeet; 1997 - potato; 1998 - durum	HH112	4/28/99	9/20/99
Flynn	1996 - Small grain; 1997 - Sugarbeet; 1998 - Small grain	HH111	4/25/99	10/12/99
Karst	1997 - Sugarbeet; 1998 - Small grain	HH111	4/26/99	10/12/99

Table 2. Stands, yields and quality of sugarbeets grown on methyl bromide-treated soil and natural soil at Eastern Agricultural Research Center, Sidney, MT.

Treatment	Seedling stand, plants/ac	Harvest stand, plants/ac	Sucrose %	Root yield, tons/acre	Sucrose yield, lb/acre	Extractable Sucrose, lb/acre
Fumigated	34650	31780	16.47	26.3	8690	7953
Natural	39160	35900	17.28	27.4	9481	8808
probability	0.017	0.028	< 0.001	0.454	0.064	0.041
CV (s/mean)	6.6	7.5	1.1	7.2	6.7	7.0

Treatment	Na ppm	K ppm	Amino-N ppm	Impurity index	SLM	Extraction %
Fumigated	328	2366	239	0.93	1.40	91.5
Natural	267	2139	203	0.82	1.23	92.9
probability CV (s/mean)	0.049 14.5	0.033 6.5	0.055 12.0	0.018 7.0	0.016 6.9	0.005 0.6

Table 3. Stands, yields and quality of sugarbeets grown on methyl bromide-treated soil and natural soil at the Jim Karst farm, Fairview, ND.

Treatment	Seedling stand, plants/ac	Harvest stand, plants/ac	Sucrose %	Root yield, tons/acre	Sucrose yield, lb/acre	Extractable Sucrose, lb/acre
Fumigated	40730	36060	18.50	32.9	12190	10440
Natural	45180	37990	18.58	30.9	11490	9870
probability CV (s/mean)	0.047 7.3	0.371 8.2	0.707 1.3	0.525 12.3	0.540 12.2	0.570 12.2

Treatment	Na ppm	K ppm	Amino-N ppm	Impurity index	SLM	Extraction %
Fumigated	524	2021	219	0.90	1.34	92.7
Natural	535	1869	216	0.86	1.29	93.1
probability CV (s/mean)	0.962 18.9	0.510 15.4	0.933 8.5	0.633 10.7	0.636 10.6	0.618 0.9

Table 4. Stands, yields and quality of sugarbeets grown on methyl bromide-treated soil and natural soil at the Charles Flynn farm, Fairview, ND.

Treatment	Seedling stand, plants/ac	Harvest stand, plants/ac	Sucrose %	Root yield, tons/acre	Sucrose yield, lb/acre	Extractable Sucrose, lb/acre
Fumigated	42350	41750	19.44	24.0	9202	8047
Natural	41330	28920	18.89	18.8	7126	6247

probability CV (s/mean)	0.665 6.3	0.055 26.9	0.240 3.6	0.386 39.0	0.350 38.6	0.354 38.4

Treatment	**Na ppm**	**K ppm**	**Amino-N ppm**	**Impurity index**	**SLM**	**Extraction %**
Fumigated	286	1711	129	0.65	0.98	95.0
Natural	295	1457	136	0.60	0.90	95.2
probability CV (s/mean)	0.908 16.8	0.001 4.8	0.694 16.0	0.088 7.6	0.098 7.4	0.319 0.4

Table 5. Stands, yields and quality of sugarbeets grown on methyl bromide-treated soil and natural soil across three sites in the Mondak region.

Treatment	**Location**	**Seedling stand, plants/ac**	**Harvest stand, plants/ac**	**Sucrose %**	**Root yield, tons/acre**	**Sucrose yield, lb/acre**	**Extractable Sucrose, lb/acre**
Fumigated		39240	36530	18.14	26.3	9478	8813
Natural		41890	34270	18.25	24.4	8888	8309
	EARC	36910	33840	16.88	26.9	9085	8381
	Flynn	41850	35330	19.17	19.7	7534	7147
	Karst	42960	37030	18.54	29.4	10930	10150
ANOVA	L T L x T	< 0.001 0.005 0.020	0.505 0.314 0.008	< 0.001 0.545 0.026	0.004 0.414 0.563	0.009 0.479 0.416	0.014 0520 0.388

Treatment	**Location**	**Na ppm**	**K ppm**	**Amino-N ppm**	**Impurity index**	**SLM**	**Extraction %**
Fumigated		379	2033	196	0.83	1.24	93.1
Natural		366	1821	185	0.76	1.14	93.7
	EARC	298	2252	221	0.88	1.32	92.2
	Flynn	291	1584	132	0.62	0.94	95.1
	Karst	529	1945	218	0.88	1.32	92.9
ANOVA	L T	< 0.001 0.728	< 0.001 0.002	< 0.001 0.257	< 0.001 0.011	< 0.001 0.010	< 0.001 0.011

	L x T	0.687	0.785	0.136	0.464	0.419	0.130

Figure 1.

The plot on the left side of this photo was fumigated with methyl bromide. The plot on the right side of this photo is growing on natural soil. Photo was taken on the Charles Flynn Farm, Fairview, ND, 1999.

Figure 2.

Fusarium was identified as the primary cause for reduction in sugarbeet stand a the Charles Flynn Farm, Fairview, ND, 1999.

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